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PELVIC BONE SYSTEM CHANGES AND PATHOGENESIS OF GENITAL PROLAPSE – A RADIOPELVIMETRIC STUDY –

KOŠTANI SISTEM ZDJELICE I STATIKA ZDJELIČNIH ORGANA

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Original paper

Key words: genital prolapse, etiopathogenesis of genital prolapses, pelvis anthropology, pelvic bone system, erect posture in humans

Summary. Radiopelvimetric investigations, on the colpocystographies in I position, are carried out on 476 patients: 392 genital prolapses and 84 control cases in the period from April 1, 1968 to February 28, 1973. Out of classic pelvic bone parameters, an original measure – distance »X« is introduced, which characterizes the anterior compartment of the pelvis directly exposed to the action of the intra-abdominal force.

The pelvic bone system of prolapse cases presents a horizontalization and an infundibular caudal enlargement. Thus, in total uterine prolapses, the middle pelvis is larger for 6.7%, the pelvic outlet for 13.8% and the distance »X« is longer for 56.7%; the pelvic inlet is more horizontal for 9.8° in comparison to the control cases. The nutation of the sacrum, associated with dorsal transposition of its inferior part and the antero-posterior rotation of the whole pelvis around a center located in the acetabulum seem to be the causes. The relations of these changes to the aging process are studied, too. Showing quantitative identity with changes found in prolapse cases, this analysis also demonstrates their clear progress parallel to the patients aging. In the group of patients aged over 61 years, the horizontalization is more accentuated (14.5°) than the infundibular caudal pelvic enlargement; the distance »X« is longer for 91.4% and nutation, curving and »shortening« of the sacrum are found in comparison with patients aged less than 30 years. In contrast, the pelvis of the control cases, without relation to their age, looks like the pelvis of young patients aged less than 30 years and to the pelvis of nulliparous women aged less than 35 years. Consequently, it is possible to suppose that a part of the population, who during their whole life preserve »youthful« form of the pelvis, should be protected from prolapse development. As such bone changes could be provoked by overloading due to human erect position, they could represent the mechanism by which the aging and the body overloading influence the development of genital prolapses.

Due to the enlargements of the middle pelvis and of the pelvic outlet, pelvic suspension and sustention systems are exposed to distensions, provoking a decrease of arrows of their cupolas with a consequent decrease of resistance and deterioration. The calculations demonstrated that the resistance of the pelvic diaphragm in the total uterine prolapses group is three times lower than in the control cases. On the other hand, the augmentation of distance »X« in the group of patients aged over 61 years, exposes their ventral pelvic compartment to a three times greater force in comparison to that of the group of patients aged less than 30 years. By introducing a biomechanical approach, the author throws a new light on this domain of gynecology, permitting better understanding of the complex pathogenesis of genital prolapse, which enables a more sophisticated prevention and treatment of this disease.

Izvorni članak

Ključne riječi: genitalni prolaps, etiopatogeneza, antropologija zdjelice, zdjelični koštani sistem, uspravni stav čovjeka

Sažetak. Autor prikazuje vlastita iskustva s radiopelvimetrijom koštanog sistema zdjelice 476 pacijentica: 392 prolapsa i 84 kontrolnih slučajeva, ispitivanih u periodu od 1. travnja 1968. do 28. veljače 1973. Mjerenja su vršena na kolpocistografijama, u prvoj poziciji – tijekom kontrakcije zdjelične dijafragme. Osim klasičnih parametara, koji služe za karakterizaciju koštanog sistema zdjelice, uvedena je jedna originalna mjera, nazvana distancija »X«. Ona karakterizira prednji pelvični kompartiment, koji je izložen direktnom djelovanju intra-abdominalne sile.

Rezultati pokazuju, da koštani sistem zdjelice kod genitalnih prolapsa prezentira jasnu horizontalizaciju i infundibularno kaudalno proširenje. Tako, u grupi totalnih prolapsa maternice sredina zdjelice je šira za 6,7%, karlični izlaz za 13,8%, pubo-kokcigealna distancija za 16,3% i distancija »X« za 56,7% u odnosu na kontrolne slučajeve. Što se odnosi do hori-

zontalizacije, sakro-kotiloidna distancija je horizontalnija za 6,5°, ulaz zdjelice za 9,8°, zdjelična sredina za 8,3°, zdjelični izlaz za 5,5°, pubo-kokcigealna distancija za 6,3° i sakralna plato za 4,6° u odnosu na kontrolne slučajeve. Razlozi za ovakve promjene se trebaju tražiti u ovješenosti sakruma, koja je asocirana dorzalnom transpozicijom njegova donjeg dijela i antero-posteriornoj rotaciji cijele zdjelice oko jednog centra, koji je lociran u acetabulumu.

U odnosu na starosnu dob pacijentica, analiza ovih promjena pokazuje identičnost s promjenama koje su registrirane kod prolapsa, pri čemu se konstatira još i njihova progresivnost paralelna sa starosnim procesom. Iako, u grupi pacijentica starijih od 61 godinu, dimenzionalne promjene ulaza zdjelice su kompenzirane proširenjem i vertikalizacijom pubične simfize, sredina njihove zdjelice je šira za 6,4%, zdjelični izlaz za 7,4%, pubo-kokcigealna distancija za 12,4%, a njihova distancija »X« je veća čak i za 91,4% u odnosu na grupu pacijentica mlađih od 30 godina. Nasuprot genitalnim prolapsima, sakrum ovih pacijentica je kraći za 5,6% i Thieme-ova distancija-4 za 26,4%, dok fleš sakralne kosti je duži za 16,3%. Horizontalizacija njihove zdjelice je izraženija napredovanjem starosti: sakro-kotiloidna distancija je horizontalnija za 10,6°, ulaz zdjelice za 14,5°, sredina zdjelice za 11,6°, zdjelični izlaz za 8,7° i pubo-kokcigealna distancija za 7,7° u odnosu na grupu pacijentica mlađih od 30 godina. Pri tome, zbog »skraćenja« sakruma, ulaz njihove zdjelice izgleda da je horizontalniji nego njen izlaz.

S druge strane, koštani sistem zdjelice kontrolnih slučajeva, nezavisno od njihove starosti, skoro je identičan zdjelicama pacijentica mlađih od 30 godina i nulipara mlađih od 35 godina. Budući da modifikacije koštanog sistema zdjelice mogu biti izazvane fizičkim opterećenjem, koje se javlja zbog uspravnog položaja tijela, može se zaključiti da ove promjene predstavljaju mehanizam kojim starosni proces i fizičko opterećenje utječu na razvoj genitalnog prolapsa. Čak što više, može se pretpostaviti da populacijska skupina, koja tijekom cijelog života sačuva »mladalačku« formu karlice, ostaje zaštićena od pojave prolapsa.

Da bi sagledali ulogu ovih promjena u patogenezi prolapsa, koštani pelvični prsten i sistemi fiksacija karličnih organa najprije su uprošćeni u vidu kupola, a zatim su podvrgnuti analizi pomoću univerzalnih zakona mehanike. Zbog povećanja dimenzija sredine i izlaza zdjelice, suspenzioni i sustenzioni sistem pelvičnih organa podvrgnuti su distenzijama, koje prouzrokuju smanjenje fleša njihovih kupola, s konsekventnim povećanjem unutrašnih sila. Finalni rezultat je smanjenje rezistencije i eventualna deterioracija fiksacionih sistema.

Matematički proračuni pokazuju da je rezistencija zdjelične dijafragme u grupi totalnih prolapsa maternice oko tri puta manja nego u kontrolnih slučajeva. S druge strane, povećanje distancije »X«, u grupi pacijentica starijih od 61 godinu, izlaže ventralni kompartiment njihove zdjelice na oko tri puta veće djelovanje intra-abdominalne sile u odnosu na silu koja se razvija u grupi pacijentica mlađih od 30 godina.

Biomehaničkim prilazom problemu autor baca novu svjetlost u ovo područje ginekologije, što omogućava bolje razumijevanje kompleksne patogeneze genitalnog prolapsa i omogućava sofisticiraniji način prevencije i terapije ovog oboljenja.

Introduction

In the large sense of words, the genital prolapses represent a variety of sacro-pubic hernias developed in the region of vaginal introitus. As a pathologic entity, they have been known for a very long time. Namely, they were already known in Ancient Egypt – the first genital prolapse description was found in a papyrus of Ebers, dated from 1760–1550 B. C. Thereafter, Susruta from the Far East and Hippocrates from the Balkans had spoken about this disease. Nevertheless, in spite of efforts of many generations of gynecologists, surgeons, anatomists and medical doctors of other specialists, the etiopathogenesis of genital prolapses is stll not completely understood.

Obstetric traumatism (multiparity, short intervals between deliveries, obese babies, forced deliveries through a not completely dilated cervix, forceps and other obstetric interventions, perineal ruptures etc.) has long been held responsible, as playing an important role in the prolapse development. Besides that, many authors largely blame the weaknesses of musculo-fibrous tissues – starting from hereditary or constitutional origins[1] and continuing further with those acquired due to postmenopause, senility, malnutrition, alimentary deficiency… Moreover, they speak about the existence of racial differences in musculo-pelvic architecture, explaining the fact why the genital prolapse is more rarely found in black population, gypsies etc. (abundant or better developed musculo-fibrous tissues?!). Congenital malformations of the pelvic and perineal regions surely play a special role in the prolapse development (exp.: spina bifida). Furthermore, for a long time, it has been known that the prolapses are more frequently found in patients suffering from intra-abdominal excessivepressure conditions (asthma, chronic bronchitis, excessive physical efforts…) and after an acute traumatism.

Nevertheless, the finding that acute genital prolapses could be met in quadrupeds only during delivery suggests evocatively the important role of changes related to the evolution of species, during the passage from horizontal to erect position of the human body. Evidently, during these evolutional changes, the vertebral spine above the sacral region was subjected to a rotation of 90°, while the approximate rotation of the sacrococcygeal part was only 45°. It is clear that during these evolutional phenomena related to the passage of quadrupedal to bipedal position the pelvic bone system is subjected to very important changes. At first, it should be emphasized, that the process of this orthogonal rotation is not uniform, nor is it perfectly completed in all individuals.[2–5] Out of racial differences, many individual, hereditary and constitutional variations explain the numerous variability of the pelvic morpho-topography and the complexity of the studies related to this area. Apart from the phylogenic differences, appeared during evolution in this new position, there are also numerous acquired changes, whose etiopathogenesis is very complex, too. In this context, it is very logical to insist on the important role of the corporeal overloading in the development of acquired pel-

vic bone changes related to the bipedal position: heavy work, obesity, overloading related to pregnancy, delivery, nursing etc. If these changes fall under of the pelvic bone morpho-topography, maladjusted to the demands of new pelvic statics, they should also be a cause for degradation of the static equilibrium of the pelvic homeostasis.

Starting from these ideas and being intrigued by the results of excellent radiopelvimetric studies of Darmaillacq et coll.,[6] Torpin,[7] Matulewitcz,[8] etc. on the pelvic bone changes associated with genital prolapses, during 1968, we started with radiopelvimetric investigations of the pelvic bone morphotopography in women suffering from genital prolapse.

Material

The material represents a series of 476 patients: 392 obtained from different forms of prolapse and 84 control cases. The investigation period extended from April 1, 1968 to February 28, 1973. In order to facilitate the comparison and statistic work up, the patients are separated in 5 groups:

1. *Group A – 340 genital prolapses* of different types and of different severity (mean age 46.6 years). As to the classification, we use a very simple and surgically very effective classification of prolapse elements – two grades only: intravaginal, denominated by a suffix ptosis, and exteriorized, denominated by a suffix coele.

This group comprises 244 uterine prolapses, classified in four grades: hysteroptosis (intravaginal) less than 30 mm (n=113); hysteroptosis (intravaginal) over 30 mm (n=56); hysterocoele – subtotal (only uterine cervix exteriorized) (n=45) and hysterocoele – total (uterus totally exteriorized) (n=30).

The prolapse of the anterior vaginal wall is registered in 318 cases: cystoptosis or anterior colpoptosis (intravaginal) (n=252) and cystocoele or anterior colpocoele (exteriorized) (n=66).

The prolapse of the posterior vaginal wall is registered in 212 cases: rectoptosis or posterior colpoptosis (intravaginal) (n=170) and rectocoele or posterior colpocoele (exteriorized) (n=42).

The elongation of uterine cervix is registered in 40 cases: intravaginal (n=11) and supravaginal (n=29). The isolated rectoceles and enterocoeles are excluded from this group.

2. *Group B – 52 isolated rectocoeles* (mean age 44.4). These prolapse elements are studied separately because their pathogenesis is different from that of other prolapse elements. Therefore, the isolated rectocoeles could be also used as control cases.

3. *Group C – 15 isolated urinary stress incontinences* – cases without any prolapse element (mean age: 46.1 years). These patients could be equally used as control cases.

4. *Group D – real control group, consisting of 34 patients* (mean age: 41.3 years), composed of women not presenting any prolapse element, in spite of the exposure to conditions which could be deliberately held responsible for prolapse etiopathogenesis (multiparity, childbirth of babies over 4500 gr., heavy work, postmenopause, perineal ruptures etc.). It is important to underline that these patients do not present any other pathology which could directly or indirectly influence the pelvic statics (parametritis, tumors etc.).

5. *Group E – comprising 35 nullipares aged less than 35 years* (mean age: 29.5 years), treated for sterility, in whom, with their consent, after hysterosalpingography, a profile pelvigraphy was made under the same conditions as those for colpocystography.

Such a distribution of material permits many combinations. On the one hand, there is a possibility to study genital prolapse as an integral group (A) or to study each element separately (colpopoptosis or colpocoele, anterior or posterior, hysteroptosis or hysterocoele, cervical elongation, stress urinary incontinence) or as associated phenomena. On the other hand, some of the groups (B and C) could be added to the real control group (D) and consequently an augmented control group (B+C+D) could be formed, permitting even more significant comparisons. In this way, two large groups are formed: group A=340 cases (mean age: 46.6 years) and group B+C+D= 101 cases (mean age: 43.6 years). Finally, if the nulliparous group (E) is added to this augmented control group (B+ C+D), we could increase the control group (B+C+ D+E=136 cases) even more.

In order to eliminate inadequate conclusions, first, all groups are analyzed separately and then, if they behave homogenously in statistical operations (standard deviations, test of significance etc), they could be intergrated in »larger control group«.

Method

All patients are submitted to a uniform protocol, comprising routine examinations; special clinical tests, for detection of masked prolapse elements or for masked stress incontinence; cystoscopy or urethrocystoscopy (if necessary); cystometry and finally, colpocystography, which represents the fundamental part of our investigations.

Our technique of colpocystography represents[9] a variant of the method described by Béthoux and Borry.[10] The examination is carried out in erect position, in real profile (estimated by superposition of femoral bones), during contraction of the pelvic diaphragm (I position) and during maximum bearing down (II position); dimension of films of 45×45 cm. Pelvic viscera are opacified by sterile barium suspensions of different density, suitable for anatomic characteristics of the respective organs (very dense paste for urethra, solution for bladder, etc…).

The pelvimetric method always uses a standard distance between the anti-cathode and the central sagittal plane of the body, passing through the middle point between the feet of the patient, slightly separated. Radiography is centered at the level of trochanter major.[9–11] In

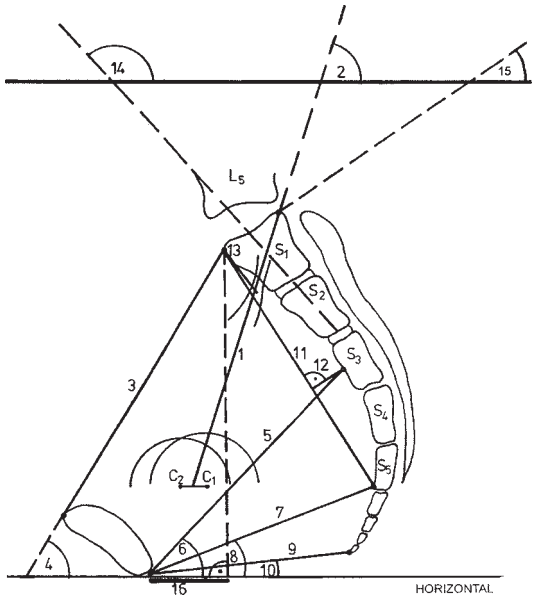

Figure 1. Parameters characterizing pelvic bone system
Slika 1. Parametri koji karakteriziraju koštani sistem zdjelice

order to decrease statistic deviations of the measured parameters due to anthropologic differences, the cotylosacral distance – the most constant pelvic measure – is used as a scale.[6,11] Therefore, all other metric measures represent the function of this referral value (each respective parameter is divided by the value of the cotylosacral distance and the quotient is used in further statistcal operations). The respective angles, however, are measured in relation to the horizontal plane and are presented in real values. The measurements are done on the colpocystography, in position I, namely, during contraction of the pelvic diaphragm.

Studied parameters represent distances and angels used in classic radiology and anthropology for characterization of the morphology and topography of the pelvic bone system *(Fig. 1)*. Some of these parameters are also used by Darmaillacq et al.,[6] Torpin,[7] Matulewitcz et al.,[8] Wangermez et al.,[11] Dippel,[12] Hannah,[13] Thieme,[14] etc. However, in our study, we introduced an original parameter, nominated »distance X«, characterizing anterior part of the pelvis, which is open to direct action of the intra-abdominal force.[15]

1. Cotylosacral distance or cotylosacral axis – going from the posterior border of the sacral plateau to the middle of the line, unifying centers C_1 and C_2 of femoral heads. As we already mentioned, this measure represents the least variable pelvic parameter and, thereafter, is used as a scale in our study. For that purpose, only this distance is presented in real metric values – it is measured directly on the film and includes the respective radiological enlargement. The values of other distances are functions of the cotylosacral distance (quotient of their division by the cotylosacral distance).

2. Inclination of the cotylosacral distance in relation to the horizontal.

3. Anatomic diameter of the pelvis: distance between the superior border of the pubic symphysis to the anterosuperior edge of the first sacral vertebra (pelvic inlet).

4. Inclination of the anatomic diameter in relation to the horizontal.

5. Pubosacral distance at the level of the third sacral vertebra (S_3), characterizing the middle pelvis. It starts from the inferior border of the pubic symphysis to the middle of anterior surface of the third sacral vertebra.

6. Inclination of the pubosacral S_3 distance in relation to the horizontal.

7. Pubosacral distance at the level of the fifth sacral vertebra (S_5), representing the pelvic outlet. It starts from the inferior border of the pubic symphysis to the anterior edge of sacral point (inferior extremity of the S_5).

8. Inclination of the pubosacral S distance in relation to the horizontal.

9. Pubococcygeal distance, going from the inferior border of the pubic symphysis to the apex of the coccyx.

10. Inclination of the pubococcygeal distance in relation to the horizontal.

11. Length of the sacrum: distance between anterosuperior angle of the first sacral vertebra to the sacral point.

12. Sacral curvature – sacral arrow: vertical distance between the line, unifying the anterosuperior angle of the first sacral vertebra and the ventral border of the sacral apex, from one side, and the middle point of anterior surface of the third sacral vertebra, from the other.

13. Distance 4 by Thieme: going from the anterosuperior angle of the first sacral vertebra (»sacral promontorium«) to intersection of the arched lines with anterior surface of the sacrum.

14. Angle 8 by Thieme – inclination of the sacrum: angle between the line, connecting the centre of the sacral plateau and the center of intervertebral discus S_{2-3}, with the horizontal.

15. Angle 6 by Thieme – inclination of the superior plateau of the sacrum: angle between the line, continuing superior surface of the first sacral vertebra and the horizontal.

16. Distance »X«: horizontal distance between the inferoposterior border of the pubic symphysis and the vertical line, passing through the anterosuperior angle of the first sacral vertebra. Representing a still not described parameter characterizing the pelvic bone system, we introduced an original name – the distance »X«. As we have mentioned it represents locality, where in erect position, the intra-abdominal pressure exerts a vertical force acting downwards, directly over the fibro-muscular pelvic structures. Keith[2,3] compared its action to that of a hydraulic hammer.

The statistic study includes the computer calculation of mean arithmetic values (MAV), standard deviation (SD) and tests of significance (p). The analyses are carried out separately for each studied group (A, B, C, D, E) and also for the control groups, enlarged by addition: B+C, B+C+D and B+C+D+E. After the investigation of

integral prolapses (group A), the study continues by analysis of separated prolapse elements (hysteroptosis to 30 mm and over, subtotal and total hysterocele, concomitant and sliding bladder prolapse, rectocoele, elongation of the cervix etc).

Concerning the age, all patients are divided in following groups: less than 30 years, from 31–40, from 41–50, from 51–60 and over 61 years.

Results

Mean arithmetic values, standard deviations and differences between the studied groups are presented on *Tables 1 and 2*. *Table 1* clearly shows significant differences between control groups, integral prolapse group and different types of uterine prolapses. The uterine prolapse is the most representative element for the study, so our further investigations are concentrated to different degrees of uterine prolapses, only. The data of such an analysis are acceptable and could be transferred to other prolapse elements. The *Table 2* compares the data for different age groups.

In order to facilitate the analysis and to obtain more impressive presentation of the pelvic bone changes, the schematic designs in appropriate proportion are made up. The mean arithmetic values are used to draw the schemes of pelvic bone system of examined groups *(Tables 1 and 2)*. The value of the cotylosacral distance is figured out arbitrarily at 10 cm (value, very close to reality; figures in tables correspond to real measurements on radiological films) and used as a scale on the schemes. The sketch always starts from an arbitrary point: the inferior border of the pubic symphysis, so, this point is superposed on all our designs. Other parts of the design are drawn by using respective parameters. For better visual impression, the shapes of pelvic bones are approximately drawn in natural forms.

1. Summary of the pelvic bone system changes related to genital prolapse

In *Fig. 2*, the drawing compares the pelvic bone systems of the integral prolapse group (A) to the enlarged control group (B+C+D). At first glance, it is evident that the pelvis of genital prolapses (group A, the situation 2. in *Fig. 2*) is more horizontal and presents a caudal infundibular enlargement; the sacrum is rejected back and downward; the pubic symphysis is larger and its axis is more vertical than that of the controls (group B+C+D, the situation 1. in *Fig. 2*).

Fig. 3 presents the scheme of the pelvic bone systems of the total uterine prolapses (total hysterocoeles) and that of the control group (B+C+D). It is evident that the differences are more accentuated. The sacrum is more pushed backward and downward and the pubic symphysis is much larger and much more vertical than that with the control group.

The modifications of pelvic bone morphotopography could be analyzed in two aspects: dimensional and inclinational changes.

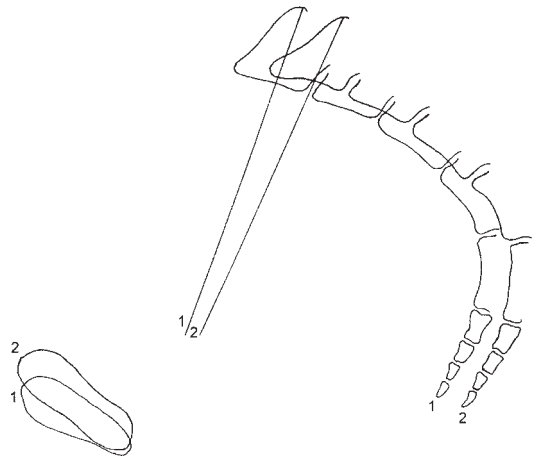

Figure 2. Schematic drawing of the pelvic bone systems of control group B+C+D (1) and of integral group of prolapses A (2)
Slika 2. Shema koštanih sistema zdjelica kontrolne grupe B+C+D (1) i integralne grupe prolapsa A (2)

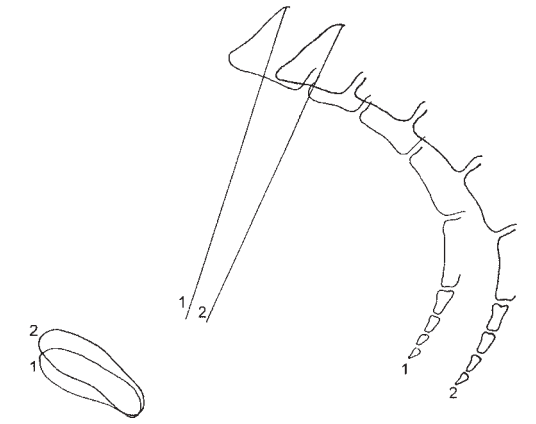

Figure 3. Schematic drawing of the pelvic bone systems of the control group B+C+D (1) and of total uterine prolapses (2)
Slika 3. Shema koštanih sistema zdjelice kontrolne grupe B+C+D (1) i totalnih prolapsa maternice (2)

1.1. *Dimensional changes*. On *Table 1*, it is evident that in the total uterine prolapse group (total hysterocoeles), the cotylosacral distance is 4.2% shorter than in the control group (B+C+D) ($p<0.13$), meaning that the superior part of the sacrum is slightly impressed into the pelvic cavity. It should be accepted, however, that changes of the pubic symphysis (virtualization and enlargements) are compensatory. These findings explain that practically the pelvic inlet (anatomic diameter) is not changed (+1%). Nevertheless, the middle pelvis (pubo-S_3 distance) is for 6.7% longer ($p<0.04$), the pelvic outlet (pubosacral or pubo-S_5 distance) for 13.8% ($p<0.0002$) and pubococygeal distance is much longer for 16.3% ($p<0.0002$). However, the greater difference is found at the level of the distance »X«, which is augmented for 56.7% ($p<0.00003$) in relation to the control group.

In conclusion, generally speaking, the patients suffering from genital prolapse present a light nutation of their sacrum, which produces a retroposition of its caudal part.

Table 1. Percentage of distance changes or of angle differences of mean arithmetic values of parameters characterizing the pelvic bone system of different grades of uterine prolapses versus control cases (B+C+D)

Tablica 1. Postotak promjena distancija i razlika u kutovima srednjih aritmetičkih vrijednosti parametara koji karakteriziraju koštani sistem zdjelice, kod različitih stupnjeva uterinih prolapsa u odnosu na kontrolne slučajeve (B+C+D)

Parameter	Control group B+C+D (n=101)	Prolapses (A) (n=340)		Hysteroptoses Less than 30 mm (n=113)		Hysteroptoses over 30 mm (n=56)		Hysteroceles subtotal (n=45)		Hysteroceles total (n=30)	
	MAV SD	MAV SD	Differ.	MAV SD	Differ.	MAV SD	Differ.	MAV SD	Differ.	MAV SD	Differ.
SC Distance (real value)	159.5±20.9	158.3±16.4	–0.8%	161.2±19.9	1.1%	157.9±27.2	–1.0%	156.5±27.7	1.9%	152.9±31.1	–4.2%
Inclination of SC distance	71.6°±11.1°	66.7°±8.4°	–4.8°	67.9°±9.4°	3.7°	68.2°±11.7°	3.4°	66.6±13.1°	5.0°	65.1°±15.1°	6.5°
Anatomic diameter	1.055±0.12	1.05±0.10	–0.5%	1.041±0.11	–1.3%	1.065±0.18	0.9%	1.052±0.17	–0.3%	1.066±0.21	1.0%
Inclination of anatom. diam.	57.6°±10.6°	51.8°±9.2°	–5.8°	53.2°±10.1°	–4.4°	54.3°±11.7°	–3.2°	49.7°±12.1°	–7.8°	47.8°±12.4°	–9.8
Pubo-S_3 distance	1.155±0.14	1.187±0.14	2.8%	1.163±0.15	0.7%	1.200±0.22	3.9%	1.194±0.21	3.4%	1.232±0.25	6.7%
Inclination of pubo-S_3 dist.	50.8°±8.6°	45.2°±7.5°	–5.6°	46.4°±8.3°	–4.4°	47.7°±9.9°	–3.0°	44.1°±10.1°	–6.7°	42.5°±10.8°	–8.3°
Pubo-S_5 distance	1.032±0.14	1.082±0.15	4.8%	1.055±0.14	2.2%	1.099±0.23	6.5%	1.131±0.21	9.6%	1.174±0.24	13.8%
Inclination of pubo-S_5 dist.	24.8°±7.3°	21.1°±7.7°	–3.7°	21.6°±7.6°	–3.2°	24.0°±7.7°	–0.8°	20.4°±7.6°	–4.4°	19.3°±8.2°	–5.5°
Pubo-coccygen distance	0.846±0.13	0.899±0.12	6.2%	0.878±0.13	3.8%	0.908±0.18	7.4%	0.951±0.19	12.5%	0.983±0.20	16.3%
Inclination of pubo-coccyg.	43.3°±9.1°	39.8°±8.5°	–3.5°	41.4°±9.8°	–1.9°	43.6°±9.4°	0.3°	38.9°±10.8°	–4.4°	37.0°±12.4°	–6.3°
Length of sacrum	0.949±0.14	0.944±0.12	–0.5%	0.934±0.12	–1.6%	0.957±0.20	0.8%	0.944±0.17	–0.6%	0.946±0.20	–0.3%
Sacral curvature	0.187±0.06	0.191±0.05	2.1%	0.189±0.05	1%	0.186±0.06	–0.5%	0.180±0.06	–3.8%	0.191±0.06	2.1%
Distance 4 of Thieme	0.089±0.05	0.087±0.04	–2.3%	0.090±0.05	1.1%	0.091±0.05	2.2%	0.091±0.05	2.2%	0.087±0.06	–2.3%
Angle 8 of Thieme	146.6°±17.3°	146.5°±13.2°	–0.1°	145.8°±18.6°	0.7°	148.0°±22.0°	1.4°	146.2°±24.3°	–0.3°	147.5°±30.0°	0.9°
Angle 6 of Thieme	43.5°±10.4°	40.2°±9.9°	–3.3°	40.9°±10.3°	–2.6°	40.7°±11.1°	–2.8°	39.5°±13.3°	–4.0°	38.9°±14.5°	–4.6°
Distance »X«	0.271±0.15	0.372±0.15	37.3%	0.346±0.16	27.7%	0.319±0.15	17.5%	0.408±0.20	50.5%	0.425±0.16	56.7%

MAV – mean arithmetic value/srednja aritmetička vrijednost; SD – standard deviation/standardna devijacija; Differ. – percentage of difference in relation to controls (B+C+D)/postotak razlika u odnosu na kontrolne slučajeve (B+C+D)

Table 2. Percentage of distance changes or of angle differences of mean arithmetic values of parameters characterizing the pelvic bone system of different grades of uterine prolapses versus control cases (B+C+D)

Tablica 2. Postotak promjena distancija i razlika u kutovima srednjih aritmetičkih vrijednosti parametara koji karakteriziraju koštani sistem zdjelice, kod različitih stupnjeva uterinih prolapsa u odnosu na kontrolne slučajeve (B+C+D)

Parameter	Age groups Less than 30 years (n=43)	41–50 years (n=184)		Over 61 years (n=32)		Control group of nullipares (E) (n=35)		Control group B+C+D (n=101)		Total hysteroceles (n=30)	
	MAV SD	MAV SD	Differ.	MAV SD	Differ.	MAV SD	Differ.	MAV SD	Differ.	MAV SD	Differ.
SC distance (real value)	162.2±27.6	157.3±18.3	–3.0%	160.1±37.2	–1.3%	163.9±31.2	1.1%	159.5±20.9	–1.6%	152.9±31.1	–5.8%
Inclination of SC distance	71.8°±13.2	68.6°±9.5°	–3.2°	61.3°±15.1°	–10.6°	74.3°±14.5°	2.5°	71.6°±11.1°	–0.2°	65.1°±15.1°	–6.7°
Anatomic diameter	1.072±0.18	1.045±0.13	–2.5%	1.060±0.24	1.2%	1.059±0.19	–1.2%	1.055±0.12	–1.6%	1.066±0.21	–0.6%
Inclination of anatom. diam.	59.8°±12.0°	53.7°±10.0°	–6.1°	45.3°±13.7°	–14.5°	59.82°±13.4°	0.0	57.6°±10.6°	–2.2°	47.8°±12.4°	–12.0°
Pubo-S_3 distance	1.127±0.20	1.179±0.15	4.6%	1.199±0.28	6.4%	1.124±0.22	–0.3%	1.155±0.14	2.4%	1.232±0.25	9.3%
Inclination of pubo-S_3 dist.	51.1°±10.6°	47.3°±8.2°	–3.8°	39.5°±11.7°	–11.6°	52.7°±11.7°	–1.6°	50.8°±8.6°	–0.3°	42.5°±10.8°	–8.6°
Pubo-S_5 distance	1.001±0.17	1.073±0.15	7.2%	1.075±0.27	7.4%	0.980±0.19	–2.1%	1.032±0.14	3.1%	1.174±0.24	17.3%
Inclination of pubo-S_5 dist.	24.5°±7.6°	22.3°±7.9°	–2.1°	15.8°±8.4°	8.7°	25.1°±7.9°	0.6°	24.8°±7.3°	0.4°	19.3°±8.2°	–5.2°
Pubo-coccygen distance	0.816±0.15	0.885±0.13	8.4%	0.917±0.23	12.4%	0.821±0.17	0.6%	0.846±0.13	3.7%	0.983±0.20	20.5%
Inclination of pubo-coccyg.	42.9°±9.8°	40.6°±8.8°	2.3°	35.1°±11.1°	–7.7°	42.9°±10.4°	0.0	43.3°±9.1°	0.4°	37.0°±12.4°	–5.9°
Length of sacrum	0.972±0.17	0.954±0.13	–1.9%	0.918±0.22	–5.6%	0.974±0.18	0.2%	0.949±0.14	–2.4%	0.946±0.20	–2.7%
Sacral curvature	0.178±0.07	0.195±0.06	9.6%	0.207±0.07	16.3%	0.191±0.07	7.3%	0.187±0.06	5.0%	0.191±0.06	7.3%
Distance 4 of Thieme	0.110±0.06	0.086±0.04	–21.8%	0.081±0.06	–26.4%	0.133±0.006	20.1%	0.089±0.05	–19.1%	0.087±0.06	–20.9%
Angle 8 of Thieme	144.3°±23.9°	147.2°±15.5°	2.9°	144.3°±32.6°	0.0	145.7°±26.6°	1.4°	146.6°±17.3°	2.3°	147.5°±30.0°	3.2°
Angle 6 of Thieme	40.2°±12.0°	41.7°±9.5°	1.5°	36.5°±12.2°	–3.7°	39.3°±10.6°	–0.9°	43.5°±10.4°	2.3°	38.9°±14.5°	–1.2°
Distance »X«	0.243±0.15	0.337±0.16	38.7%	0.465±0.20	91.4%	0.231±0.21	–4.9%	0.271±0.15	11.5%	0.425±0.16	74.9%

MAV – mean arithmetic value/srednja aritmetička vrijednost; SD – standard deviation/standardna devijacija; Differ. – percentage of difference in relation to controls (B+C+D)/postotak razlika u odnosu na kontrolne slučajeve (B+C+D)

1.2. *Inclinational changes*. On *Table 1*, it is evident, that the pelvic bone system of patients suffering from total uterine prolapse presents a clear horizontalization: the cotylosacral distance is more horizontal for 6.5° ($p<0.017$), the pelvic inlet for 9.8° ($p<0.00003$), middle pelvis for 8.3° ($p<0.00003$), pelvic outlet for 5.5° ($p<0.0002$), pubococcygeal distance for 6.3° ($p<0.004$) and the sacral plateau (Thieme's angle 6) for 4.6° ($p<0.04$) in comparison to the control group (B+C+D).

Consequently, it is possible to ascertain that the pelvis of the patients suffering of genital prolapses present clear inclinational changes, reflecting its horizontalization – diminution of the respective angles in relation to the horizontal. There is impression that their pelvis was subjected to an anteroposterior rotation around the center, located at the level of femoral heads. The causes for such a rotation should be sought in the evolution to the erect position and in the respective overloadings per se.

2. Summary of the pelvic bone system changes related to aging

Table 2 presents the results of measured parameters in function of age groups of patients. Profiting from the already described technique, by using mean arithmetic values, on *Fig. 4*, the schemes of pelvic bone system of age groups are drawn as follows: age group of less than 30 years old (sketch 2), age group of 41–50 years old (sketch 3) and the group of over 61 years old (sketch 4). In order to provide comparison, on the same figure the schemes related to the controls (B+C+D, sketch 1) and to the total uterine prolapses (sketch 5) are drawn, too.

At first sight, it is evident that the aging process provokes the same changes as those already registered with prolapses: verticalization and enlargement of the pubic symphysis, back and downward position of the sacrum, infundibular, caudal enlargement and horizontalization of the pelvic bone system. The analysis of dimensional and inclinational changes is very representative, too.

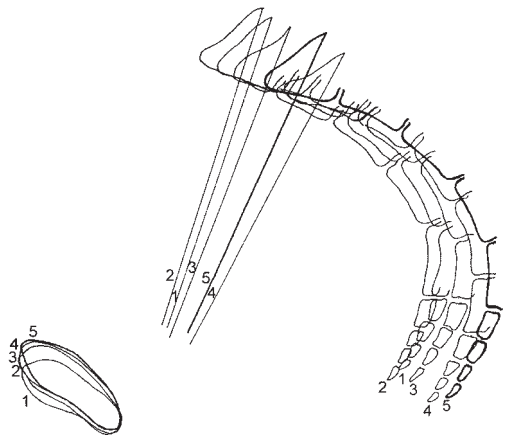

Figure 4. Schematic drawing of the pelvic bone systems of the control group B+C+D (1), of patients aged less than 30 years (2), 41–50 years (3), over 61 years (4) and of total uterine prolapses (5)

Slika 4. Shema koštanih sistema zdjelice kontrolne grupe B+C+D (1), pacijenata sa manje od 30 godina (2), 41–50 godina (3), preko 61 godine (4) i totalnih prolapsa maternice (5)

2.1. *Dimensional changes. Table 2* evidently shows that, the cotylosacral distance in patients of age group older than 61 years is not significantly shorter (–1.3%, $p<0.4$), in comparison with the age group of less than 30 years old. The changes of the pelvic inlet (anatomic diameter) are not significant (1.2%, $p<0.4$), either. It seems that the retro- and infero-position of the sacrum are compensated by the enlargement and verticalization of the pubic symphysis. However, more caudally, the middle pelvis (pubo-S_3 distance) is for 6.4% larger ($p<0.13$), the pelvic outlet (pubo-S_5 sacral distance) for 7.4% ($p<0.1$) and the pubococcygeal distance for 12.4% ($p<0.032$).

Contrary to the data registered with prolapses, changes of the sacrum related to the aging process are more important. With patients aged more than 61 years, the length of the sacrum is smaller for 5.6% ($p<0.13$), its arrow is longer for 16.3% ($p<0.04$) and the distance between »sacral promontory« and arched lines (Thieme's distance 4) diminished for 26.4% ($p<0.02$) in comparison to the group of patients less than 30 years old.

These findings impose an evident conclusion: with progress of aging, the »sacral promontory« is impressed into the pelvic brim, the length of the sacrum decreases and its curvature accentuates more and more. All these modifications clearly suggest the role of the corporeal overloading in etiopathogenesis of these changes. Nevertheless, the changes of the distance »X« are the most pronounced ones. In patients aged over 61 years, the distance »X« is 91.4% longer ($p<0.00003$) than in patients under 30 years old.

2.2. *Inclinational changes*. It is evident that the pelvic horizontalization is more accentuated with the aging process than with development of genital prolapse. Thus, in the group of patients aged more than 61 years, the inclination of the cotylosacral distance is smaller for 10.6° ($p<0.002$), of the pelvic inlet for 14.5° ($p<0.00003$), of the middle pelvis for 11.6° ($p<0.00003$), of the pelvic outlet for 8.7° ($p<0.00003$) and of the pubococcygeal distance for 7.7° ($p<0.002$) in comparison with the group of patients less than 30 years old. Due to the diminution of the length of the sacrum, the pelvic inlet seems to be more horizontal than the pelvic outlet.

It is possible to conclude, that the pelvic horizontalization is more associated with the aging process, but the pelvic enlargement represents a characteristic for the development of genital prolapse.

Discussion

1. Changes of the pelvic bone system

It is known that the human pelvis reaches its definite form at the age of 20–25 years. This fact is the starting point of our investigations. There, emerges our hypothesis that in spite of common variations, the pelvic bone system, in the largest part of female population, at age of 30 years, presents identical characteristics; that enables its classification in the group of normal pelvis described by Caldwell et al.[16–18] etc. Accuracy of this supposition could be also found in the fact that in our study, there is

no significant difference between data obtained in the group of young nullipares (E) and the data in the group of patients aged less than 30 years. Moreover, a very important finding has to be underlined: the pelvic bone system of the control group (B+C+D) does not show any significant differences in comparison to formerly mentioned groups (group E and group less than 30 years old).

The pelvic bone systems of women suffering from genital prolapses and those of certain groups of older patients present changes, characterized by their horizontalization and caudal enlargement, which make them completely different from the pelves of young nullipares (group E), of the control patients (B+C+D), or of the patients aged less than 30 years.

It seems that progressive modifications associated with the aging process, however, affect only a small part of the female population. Another part of this population presents few modifications of the pelvic bone system, related to aging. Consequent conclusion imposes that this group of population succeeded to preserve the pelvic morphotopography of a young female. To repeat once more, the proofs of this hypothesis could be found in the fact that the pelvis of the controls (group B+C+D), in spite of their advanced age, does not present significant differences in comparison to the pelvis of the patients less that 30 years old and to that of young nullipares (E).

From the biomechanical point, there is an obvious correlation between the characteristics of the pelvic bone system and characteristics of its musculofascial structures, responsible for the fixation of pelvic organs. Therefore, it is possible to admit that patients not developing prolapse, despite of age, succeeded to preserve static and dynamic equilibrium of the pelvic bone system and its musculofascial structures, in the shape while young – in other words, their pelvis did not change their youth ful appearance. Inversely, in patients developing genital prolapse, the equilibrium of fixation is broken as a result of the modifications of the pelvic bone system related to the aging process (horizontalization and progressive caudal enlargement).

As the pelvic bone changes registered with genital prolapse differ only quantitatively from the changes related to the aging process (more pronounced dimensional changes than the changes related to horizontalisation), it is possible to admit that conditions favoring the development of prolapse appear with evolution of the aging process. The fact that in the prolapse group dimensional changes are more pronounced than those in the group of patients aged over 61 years, indicates that they probably play a determining role in the prolapse genesis.

It is interesting to mention very recent computer tomography investigations by Sze et al.,[19] demonstrating the transversal enlargement of the pelvis in women with genital prolapse.

2. Etiology of changes of the pelvic bone system

Etiology of pelvic bone changes, previously described, could be connected theoretically to hereditary or constitutional characteristics of the pelvic bone system (known as an area subjected to many individual and racial variations) and exogenous factors (erect position, overloading, heavy work, obstetrical traumatism,…) or endogenous causes (osteoporosis, malnutrition,…), which could be able to decrease the resistance of human osseous framework. However, progressive and gradual evolution of these changes, related to the aging process and to genital prolapse, declares itself in favor of acquainted etiology.

3. Pathogenesis of the pelvic bone changes

Pathogenesis of the pelvic morphotopography changes could be easily explained by negative effects on human erect position. The pelvis of a newborn and of an infant have a rectilinear and canalicular form. The sacrum has a high position and the pelvic inlet gets an oval shape. Due to the erect position, the pelvic bone system is subjected to new static and dynamic relations, which play a very important role in definite formation of this region.[2–5,20] Through the spinal column, the body load is shifted to the base of the sacrum and then, through the pelvic girdle to inferior extremities. In this weight transmission, the role of the pelvic bone system could be compared to that of a twoarmed lever with fulcrum in acetabular region *(Fig. 5)*. Anterior arm of this lever commences from the iliopectineal crest and runs to the acetabulum (AO), but the posterior arm starts from the acetabulum and runs to the base of the sacrum (BO). As the posterior arm is longer, the moment of its force (in other words, the load) is greater. That explains clearly why the posterior part of the pelvis is more massive than the anterior one.

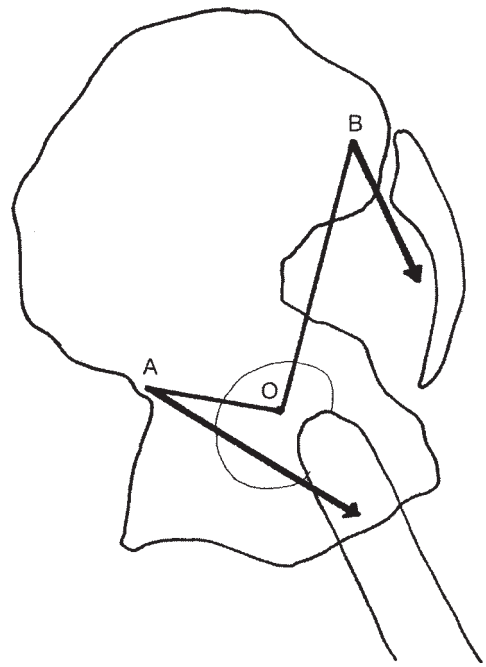

Figure 5. Biomechanically, during transmission of the body weight the pelvis plays a role of a two armed lever: AO – anterior arm and BO – posterior arm

Slika 5. S biomehaničke točke gledišta, tijekom prijenosa težine tijela, zdjelica igra ulogu dvokrake poluge: AO – prednji krak i BO – stražnji krak

The analysis of directions of forces developed on the extremities of this lever is very interesting. The force acting on the posterior arm of the lever is directed more downwards than posteriorly and it tends to dislocate the sacrum in this direction, namely, to exert pelvic horizontalization and nutation of the sacrum. The force developed on the anterior arm – shorter extremity of the lever – is directed more posteriorly than downwards and acts in order to stop this dislocation. If this equilibrium of forces is deteriorated in the way that the force acting on the posterior arm of the lever becomes more important, conditions for nutation of the sacrum and horizontalization of the pelvis are created. Due to these modifications, the sacrum takes a more inferior and a more dorsal position and the caudal part of the pelvis becomes enlarged. In order to compensate such a dislocation, the pubic symphysis becomes more massive and its axe more vertical.

Consequently, each condition provoking pelvic loading could be considered as causal factors of these morphotopographic changes. Concerning the role of obstetrical traumatism, slow progression of pelvic bone changes, which starts after 30 years of age, and occurrence of prolapses, generally many years after the childbirth, indicate a very long process, in which the obstetrical traumatism could only represent a form of common overloading, to which a female pelvis is exposed during her life. Thus, if the acute obstetrical prolapses are excluded, in which delivery could be held responsible for development of the pelvic statics troubles (forced delivery through a not yet dilated cervix etc.), obstetrical traumatism could act mainly as a nonspecific pelvic overloading factor (weight of gravid uterus, delivery, holding and carrying the children etc.) adding its effect to those of the aging process.

4. Role of pelvic bone morphotopography changes in the pelvic statics and in the etiopathogenesis of genital prolapse

Supposing that pelvic bone morphotopography plays a particular role in the physiology of the pelvic statics, the place of its changes in genital prolapse etiopathogenesis has not been elaborated yet. Our study will try to tackle the problem by a biomechanical approach. Namely, after an acceptable simplification of facts, we shall try to explain them by universal mechanical laws. Knowing the extreme complexity of these phenomena, our analysis will be concentrated on the changes which could be deliberately held responsible to produce very simple and evident effects – positive or negative – on the statics of pelvic organs. As a matter of fact, we shall analyze the effects of enlargement of the middle pelvis and the pelvic outlet and of augmentation of the distance »X« (collaborative study with Professor Emilan Titaru, engineer of structures, University of Bucharest, Romania).

4.1. *Enlargements of the middle pelvis and the pelvic outlet*. Each individual has a very specific equilibrium between dimensions of the pelvic bone system and the length and resistance of the suspension system and of the pelvic diaphragm (tonus of its muscular fibers and arrow of its cupola). Consequently, variations of each of these parameters change, more or less, characteristics of the system as a whole. As in genital prolapse patients, our data demonstrated a caudal pelvic enlargement, these changes should surely provoke loss of the equilibrium and induce disturbances of the statics of suspension and sustentation systems of pelvic organs. The biomechanical analysis of these phenomena helps to elucidate the situation.

It is known that the resistance of a cupola-like-structure does not solely depend on the dimensions of its surface, but also on the length of its arrow (perpendicular distance between the base and the top of a cupola). In our analysis, suspension and sustentation systems of the pelvic organs could roughly be simplified in a form of inverse cupolas. Due to the enlargement of diameter of the pelvic diameter in prolapse patients, the pelvic diaphragm is exposed to distension and consequently, to diminution of the arrow of its cupola. These relations will be better understood by presenting an example. The previously used drawing method is helpful. Supposing arbitrarily that in a patient aged less than 30 years, the cotylosacral distance is figured out to 10 cm, by our calculation, the sagittal diameter of her pelvic outlet would be figured out to 10 cm, too. If, due to aging, her pelvic outlet is exposed to an enlargement characteristics for a total uterine prolapse case, by our calculation, its diameter will augment to 11.7 cm. In the group of patients aged less than 30 years, the arrow of the pelvic diaphragm (distance between the pubosacral diameter and the anal orifice – measured in our study, too), is figured out to 3.2 cm. The increase of the pelvic outlet stretches diaphragm and consequently diminishes its arrow to 1.2 cm. Following universal mechanical laws: three-time reduction of the arrow of a cupola decreases its resistance three times, too *(Fig. 6)*.

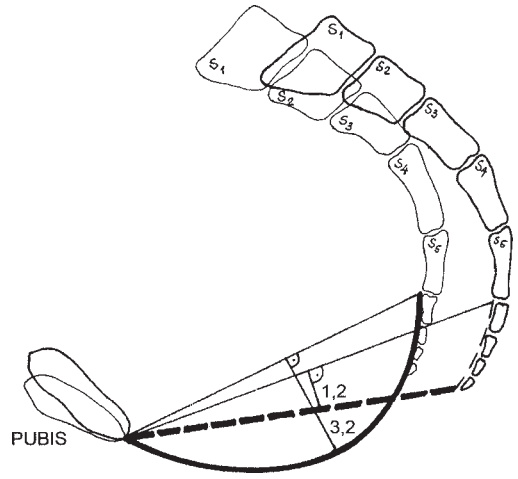

Figure 6. Schematic drawing showing the role of pelvic outlet enlargement to the pelvic diaphragm: age group less than 30 years (full line) and total uterine prolapses (dotted line). Diminution of the arrow of the pelvic diaphragm cupola for by three times also decreases its resistance also three times about

Slika 6. Shema koja prezentira ulogu proširenja zdjeličnog izlaza na dijafragmu zdjelice: starosna grupa s manje od 30 godina (puna linija) i totalnih prolapsa maternica (isprekidana linija). Smanjenje fleša kupole zdjelične dijafragme za oko tri puta smanjuje također njenu rezistenciju za oko tri puta

Concerning the suspension system of pelvic organs, the enlargement of middle pelvic diameter provokes, by analogy, the same effects on its »cupola«. By using the same conditions as in our previous example, in patients less than 30 years old, the pubosacral S_3 diameter is figured out to 11.3 cm. In case of total uterine prolapse, this diameter is increased to 12.3 cm. Reduction of the arrow of the »cupola« of the pelvic suspension system will also decrease equally its resistance.

4.2. *Increase of the distance »X«*. Here also, by using the method of example, it is possible to present clearly pelvic alterations, produced by changes of the distance »X«. In erect position, seen from above, the surface characterized by the distance »X« has an irregular shape. Roughly, it looks like a trapeze or a segment of a circle. However, in order to simplify the calculation, it will be considered as a circular surface. By profiting from a previously used drawing method, it is possible to obtain concrete results which clearly show the mechanical implications of changes of this measure. Supposing that in a patient aged less than 30 years, the cotylosacral distance is figured out to 10 cm, by our calculations, the distance »X« will be 2.43 cm *(Fig. 7, A)*. If this distance augments as in the group of patients aged more than 61 years, its value will increase to 4.65 cm *(Fig. 7, B)*. Mechanical analysis of forces in both areas characterized by the distances »X« is very impressive. During the increase of the intra-abdominal pressure to 152 mmHg or 206 cm H_2O (pressure registered during an episode of strong cough), the pressure (P) on the surface of distance »X« will be 0.2067 kg/cm^2. As it is known, the force acting over a surface is calculated as a product of pressure and size of that surface.

As distances »X« are different in both pelves used in our example, the respective surfaces (S_1 and S_2) are also

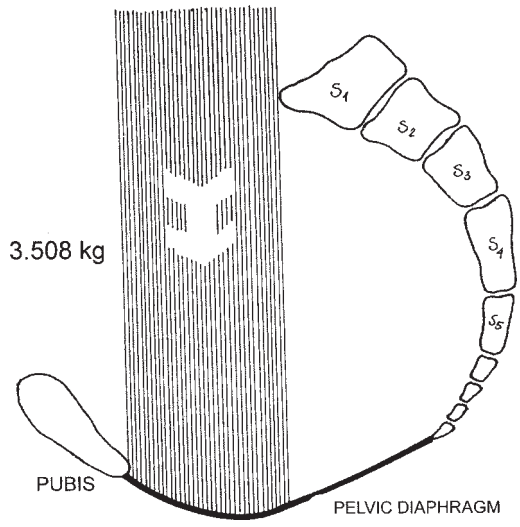

Figure 7 A. Schematic drawing of the intra-abdominal force in the area of distance »X« with the pelvic bone system characterizing the age group less than 30 years

Slika 7 A. Shema intra-abdominalne sile koja se razvija u zoni distancije »X«, koštanog sistema zdjelice karakterističnog za grupu s manje od 30 godina starosti

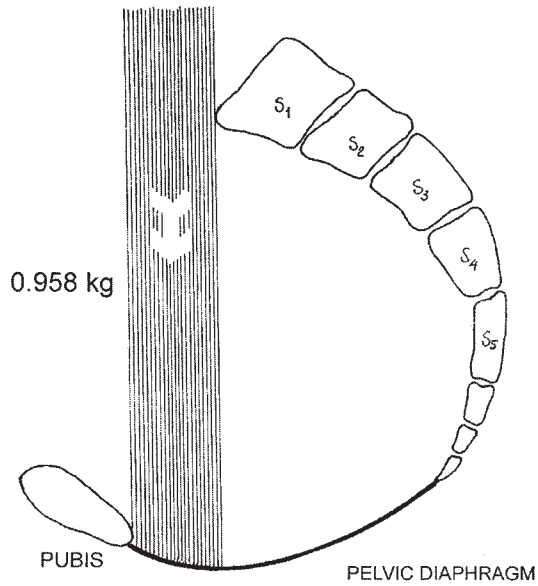

Figure 7 B. Schematic drawing of the intra-abdominal force in the area of distance »X« with the pelvic bone system characterizing the age group over 61 years

Slika 7 B. Shema intra-abdominalne sile koja se razvija u zoni distancije »X« koštanog sistema zdjelice karakterističnog za grupu preko 61 godina starosti

different and consequently, the calculated forces (F_1 and F_2) will be different, too.

By using simple arithmetic proportions, it is possible to obtain the real values of forces acting over the areas of distance »X«, in both cases:

$$F_1 = S_2 \times P = r_1^2\pi \times P$$

$$F_2 = S_2 \times P = r_2^2\pi \times P$$

Substitution of real values in the formulas gives the following results:

$$F_1 = 1.215^2 \times 3.14 \times 0.2067 = 0.958 \text{ kg}$$

$$F_2 = 2.325^2 \times 3.14 \times 0.2067 = 3.508 \text{ kg}$$

Evidently, with a woman, possessing pelvis characteristics of an individual aged over 61 years, the force acting over her distance »X« surface, will be 3.66 times greater than in a patient whose distance »X« corresponds to the data characterizing the pelvis of a patient aged less than 30 years.

5. Preventive and therapeutic implications

On the preventive plan, our results recommend to avoid the negative effects of the corporeal overloading: heavy work, obesity, conditions responsible for abdominal excessive pressure, etc… Perineal re-education should certainly play a preventive role. As far as preventive surgical measures are concerned, it is necessary to avoid operations provoking verticalization and anteposition of the genital organ axis, as: isolated hysterotorsions (Menge's, Latzko's, Baldy's, Doleris' and similar operations); high

peritonization in vesicouterine space, producing anterior tractions of genital organs; fixation of round ligament pedicles to the vaginal cuff during hysterectomy; excessive anterior repairs of the vagina; different types of anterior colposuspensions, drawing forward the anterior vaginal wall (Kocher's, Burch's, sling operations), etc… For prevention the aging changes, the hormone replacement therapy in perimenopause should be very interesting.

With regard to therapeutic implications, the prolapse surgery should favor procedures, producing dorsal transposition of the uterus and superior part of the vagina, by placing them substantially under shelter of »the roof of promontory«. Thus, we generally recommend the lumbosacral genito-supensions, but very loose, permitting pendulous movements of genital organs (a tight suspension immobilizes genitourinary organs and place the uterus or vagina in the axis of abdominal forces), shortening of the uterosacral ligaments, Douglasectomy, Mc Call's maneuver[21] during vaginal hysterectomy, sacrospinal vaginosuspension etc.

In stress incontinence surgery, we follow conceptions of our »Theory of non-permanently acting suburethral supportive structure«[22] implemented into two original operations: slinglike colposuspension and suburethral duplication of the anterior vaginal wall. These operations do not verticalize, elevate, compress or displace ventrally the proximal urethra. They intend, only, to create a resistant suburethral structure, over which the urethra will be compressed during intra-abdominal excessive pressure conditions, producing dorso-caudal physiologic displacements of this canal.

Conclusions

Radiopelvimetric investigations made from pelvigraphies in the first colpocystographic position demonstrated that the pelvic bone system of prolapse patients is more horizontal and presents a progressive caudal enlargement in comparison to the control cases. A biomechanical analysis of noxious effects of these changes shows that they provoke diminution of the resistance of the pelvic diaphragm and pelvic suspension system. Also, they expose the anterior pelvic compartment to a greater intra-abdominal force in comparison to the controls. As the pelvic changes in prolapse cases are qualitatively identical to those associated with the aging process, it is possible to presume that in a particular moment of life, due to corporeal overloading, the equilibrium of pelvic statics becomes disturbed in such a manner to provoke the development of genital prolapse.

Introducing a biomechanical approach, our results throw a new light on this gynecologic issue permit better understanding of complex etiopathogenesis of genital prolapses and announce more sophisticated preventive measures and treatment of this condition. Theoretically, it seems that they could facilitate the answers to many questions baffling the generations of investigators for a long time past:

- Why is the anterior colpocoele the most frequent and is very often the most important element in the genital prolapse picture?
- Why are the recurrent cases of anterior colpocoeles more frequent and more difficult to be treated than those of posterior colpocoeles?
- Why do the prolapses occuring in the early post-partal period stay stationary for a long time and become aggravated even during the perimenopause?
- Why are the prolapses more frequently found in women with a gynecoid pelvis than in those with android pelvis?
- Why should the surgery displace the genitourinary organs in posterior pelvic compartment, putting them in a shelter, out of direct effects of the intra-abdominal force?
- Why should the surgical practice proscribe operations producing verticalization, anteposition and anterior traction of genital organs?

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VIJESTI
NEWS

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